

## Phase Control Thyristors (Stud Version), 110 A



TO-209AC (TO-94)

### FEATURES

- High current and high surge ratings
- Hermetic ceramic housing
- Designed and qualified for industrial level
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### TYPICAL APPLICATIONS

- DC motor controls
- Controlled DC power supplies
- AC controllers

### PRODUCT SUMMARY

|                   |                      |
|-------------------|----------------------|
| $I_{T(AV)}$       | 110 A                |
| $V_{DRM}/V_{RRM}$ | 400 V, 800 V, 1200 V |
| $V_{TM}$          | 1.57 V               |
| $I_{GT}$          | 80 mA                |
| $T_J$             | -40 °C to 140 °C     |
| Package           | TO-209AC (TO-94)     |
| Diode variation   | Single SCR           |

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 110         | A                 |
|                   | $T_C$           | 90          | °C                |
| $I_{T(RMS)}$      |                 | 172         | A                 |
| $I_{TSM}$         | 50 Hz           | 2080        |                   |
|                   | 60 Hz           | 2180        |                   |
| $I^2t$            | 50 Hz           | 21.7        | kA <sup>2</sup> s |
|                   | 60 Hz           | 19.8        |                   |
| $V_{DRM}/V_{RRM}$ |                 | 400 to 1200 | V                 |
| $t_q$             | Typical         | 110         | µs                |
| $T_J$             |                 | -40 to 140  | °C                |

### ELECTRICAL SPECIFICATIONS

#### VOLTAGE RATINGS

| TYPE NUMBER            | VOLTAGE CODE | $V_{DRM}/V_{RRM}$ , MAXIMUM REPETITIVE PEAK AND OFF-STATE VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK VOLTAGE<br>V | $I_{DRM}/I_{RRM}$ MAXIMUM AT $T_J = T_J$ MAXIMUM<br>mA |
|------------------------|--------------|--|--|--|
| VS-110RKI<br>VS-111RKI | 40           | 400  | 500  | 20   |
|                        | 80           | 800  | 900  |  |
|                        | 120          | 1200   | 1300   |  |



| ABSOLUTE MAXIMUM RATINGS                             |               |   |                           |        |                    |
|--|---------------|---|---------------------------|--------|--------------------|
| PARAMETER  | SYMBOL        | TEST CONDITIONS   |                           | VALUES | UNITS              |
| Maximum average on-state current at case temperature | $I_{T(AV)}$   | 180° conduction, half sine wave   |                           | 110    | A                  |
|  |               |   |                           | 90     | °C                 |
| Maximum RMS on-state current                         | $I_{T(RMS)}$  | DC at 83 °C case temperature  |                           | 172    | A                  |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$     | t = 10 ms   | No voltage reapplied      | 2080   |                    |
|  |               | t = 8.3 ms  |                           | 2180   |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 1750   |                    |
|  |               | t = 8.3 ms  |                           | 1830   |                    |
| Maximum $I^2t$ for fusing                            | $I^2t$        | t = 10 ms   | No voltage reapplied      | 21.7   | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms  |                           | 19.8   |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 15.3   |                    |
|  |               | t = 8.3 ms  |                           | 14.0   |                    |
| Maximum $I^2\sqrt{t}$ for fusing                     | $I^2\sqrt{t}$ | t = 0.1 ms to 10 ms, no voltage reapplied   |                           | 217    | kA <sup>2</sup> √s |
| Low level value of threshold voltage                 | $V_{T(TO)1}$  | (16.7 % $\times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum |                           | 0.82   | V                  |
| High level value of threshold voltage                | $V_{T(TO)2}$  | (I > $\pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum                                      |                           | 1.02   |                    |
| Low level value of on-state slope resistance         | $r_{t1}$      | (16.7 % $\times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum |                           | 2.16   | mΩ                 |
| High level value of on-state slope resistance        | $r_{t2}$      | (I > $\pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum                                      |                           | 1.70   |                    |
| Maximum on-state voltage                             | $V_{TM}$      | $I_{pk} = 350$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse                         |                           | 1.57   | V                  |
| Maximum holding current                              | $I_H$         | $T_J = 25$ °C, anode supply 6 V resistive load  |                           | 200    | mA                 |
| Typical latching current                             | $I_L$         |   |                           | 400    |                    |

| SWITCHING  |         |   |  |        |       |
|--|---------|---|--|--------|-------|
| PARAMETER  | SYMBOL  | TEST CONDITIONS   |  | VALUES | UNITS |
| Maximum non-repetitive rate of rise of turned-on current | $di/dt$ | Gate drive 20 V, 20 Ω, $t_r \leq 1$ μs<br>$T_J = T_J$ maximum, anode voltage $\leq 80$ % $V_{DRM}$        |  | 300    | A/μs  |
| Typical delay time                                       | $t_d$   | Gate current 1 A, $di_g/dt = 1$ A/μs<br>$V_d = 0.67$ % $V_{DRM}$ , $T_J = 25$ °C                          |  | 1      | μs    |
| Typical turn-off time                                    | $t_q$   | $I_{TM} = 50$ A, $T_J = T_J$ maximum, $di/dt = -5$ A/μs<br>$V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 25 Ω |  | 110    |       |

| BLOCKING   |                          |   |  |        |       |
|--|--------------------------|---|--|--------|-------|
| PARAMETER  | SYMBOL                   | TEST CONDITIONS                                     |  | VALUES | UNITS |
| Maximum critical rate of rise of off-state voltage | $dV/dt$                  | $T_J = T_J$ maximum linear to 80 % rated $V_{DRM}$  |  | 500    | V/μs  |
| Maximum peak reverse and off-state leakage current | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = T_J$ maximum rated $V_{DRM}/V_{RRM}$ applied |  | 20     | mA    |



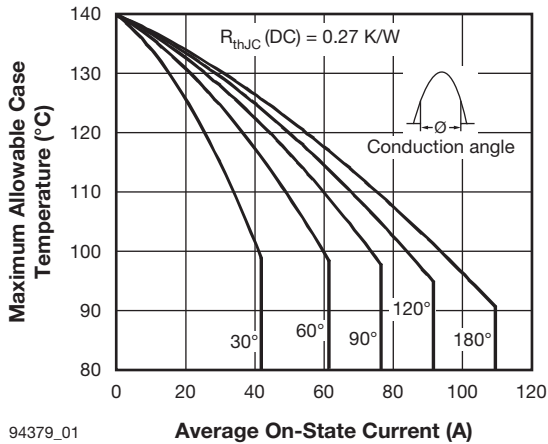
| TRIGGERING                          |             |   |                |      |       |    |
|-------------------------------------|-------------|---|----------------|------|-------|----|
| PARAMETER                           | SYMBOL      | TEST CONDITIONS   | VALUES         |      | UNITS |    |
|                                     |             |   | TYP.           | MAX. |       |    |
| Maximum peak gate power             | $P_{GM}$    | $T_J = T_J$ maximum, $t_p \leq 5$ ms  | 12             |      | W     |    |
| Maximum average gate power          | $P_{G(AV)}$ | $T_J = T_J$ maximum, $f = 50$ Hz, $d\% = 50$  | 3.0            |      |       |    |
| Maximum peak positive gate current  | $I_{GM}$    | $T_J = T_J$ maximum, $t_p \leq 5$ ms  | 3.0            |      | A     |    |
| Maximum peak positive gate voltage  | $+V_{GM}$   |   | 20             |      | V     |    |
| Maximum peak negative gate voltage  | $-V_{GM}$   |   | 10             |      |       |    |
| DC gate current required to trigger | $I_{GT}$    | Maximum required gate trigger/current/voltage are the lowest value which will trigger all units 12 V anode to cathode applied | $T_J = -40$ °C | 180  | -     | mA |
|                                     |             |   | $T_J = 25$ °C  | 80   | 120   |    |
|                                     |             |   | $T_J = 140$ °C | 40   | -     |    |
| DC gate voltage required to trigger | $V_{GT}$    | Maximum required gate trigger/current/voltage are the lowest value which will trigger all units 12 V anode to cathode applied | $T_J = -40$ °C | 2.5  | -     | V  |
|                                     |             |   | $T_J = 25$ °C  | 1.6  | 2     |    |
|                                     |             |   | $T_J = 140$ °C | 1    | -     |    |
| DC gate current not to trigger      | $I_{GD}$    | $T_J = T_J$ maximum   | 6.0            |      | mA    |    |
| DC gate voltage not to trigger      | $V_{GD}$    |   | 0.25           |      | V     |    |

| THERMAL AND MECHANICAL SPECIFICATIONS        |            |   |                  |                     |
|--|------------|---|------------------|---------------------|
| PARAMETER                                    | SYMBOL     | TEST CONDITIONS                               | VALUES           | UNITS               |
| Maximum operating junction temperature range | $T_J$      |   | -40 to 140       | °C                  |
| Maximum storage temperature range            | $T_{Stg}$  |   | -40 to 150       |                     |
| Maximum thermal resistance, junction to case | $R_{thJC}$ | DC operation                                  | 0.27             | K/W                 |
| Maximum thermal resistance, case to heatsink | $R_{thCS}$ | Mounting surface, smooth, flat and greased    | 0.1              |                     |
| Mounting torque, $\pm 10$ %                  |            | Non-lubricated threads                        | 15.5<br>(137)    | N · m<br>(lbf · in) |
|  |            | Lubricated threads                            | 14<br>(120)      |                     |
| Approximate weight                           |            |   | 130              | g                   |
| Case style                                   |            | See dimensions - link at the end of datasheet | TO-209AC (TO-94) |                     |

| $\Delta R_{thJC}$ CONDUCTION |                       |                        |                     |       |
|------------------------------|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE             | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°                         | 0.043                 | 0.031                  | $T_J = T_J$ maximum | K/W   |
| 120°                         | 0.052                 | 0.053                  |                     |       |
| 90°                          | 0.066                 | 0.071                  |                     |       |
| 60°                          | 0.096                 | 0.101                  |                     |       |
| 30°                          | 0.167                 | 0.169                  |                     |       |

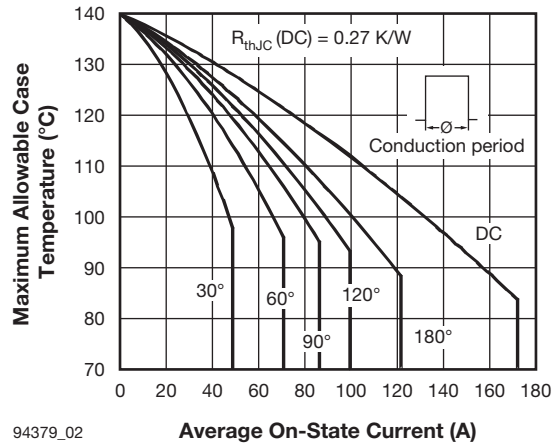
**Note**

- The table above shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC



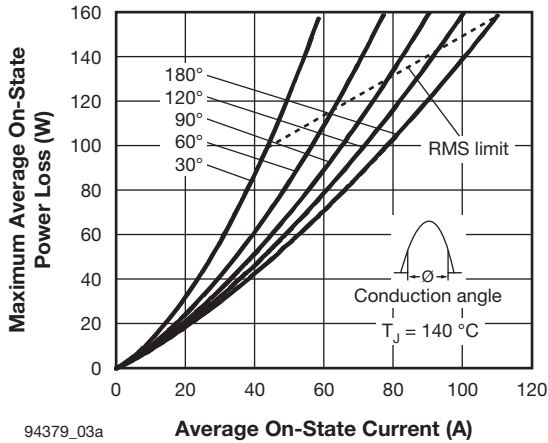
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Fig. 1 - Current Ratings Characteristics

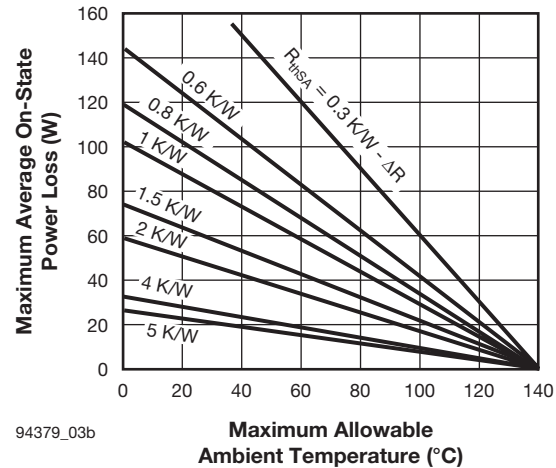


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Fig. 2 - Current Ratings Characteristics

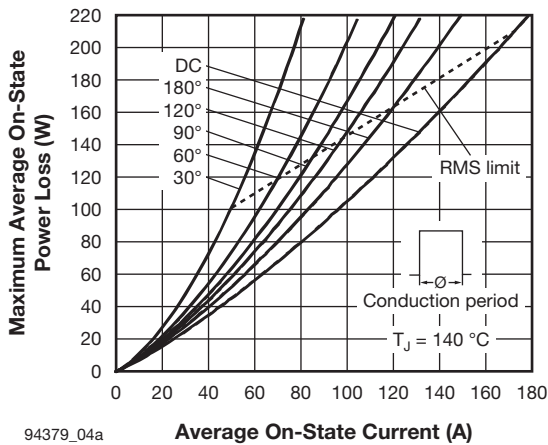


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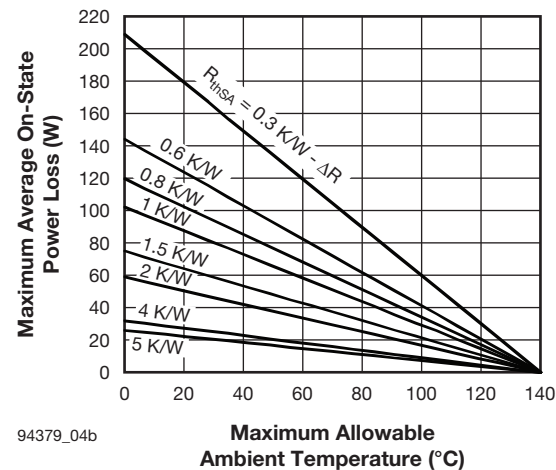


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Fig. 3 - On-State Power Loss Characteristics



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Fig. 4 - On-State Power Loss Characteristics

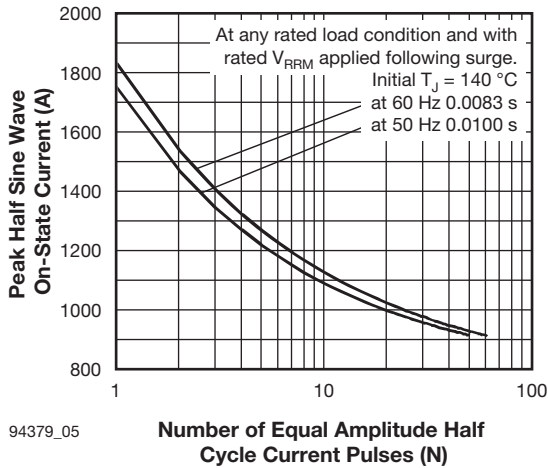


Fig. 5 - Maximum Non-Repetitive Surge Current

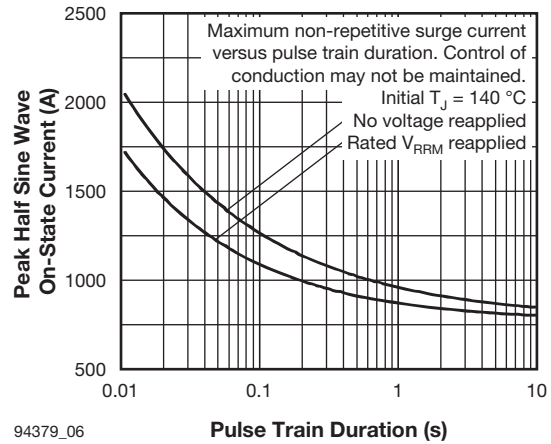


Fig. 6 - Maximum Non-Repetitive Surge Current

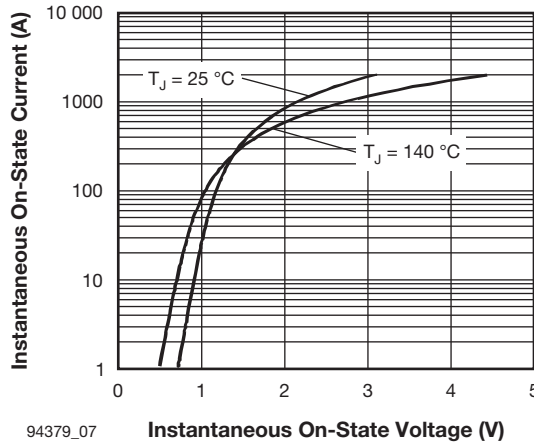


Fig. 7 - On-State Voltage Drop Characteristics

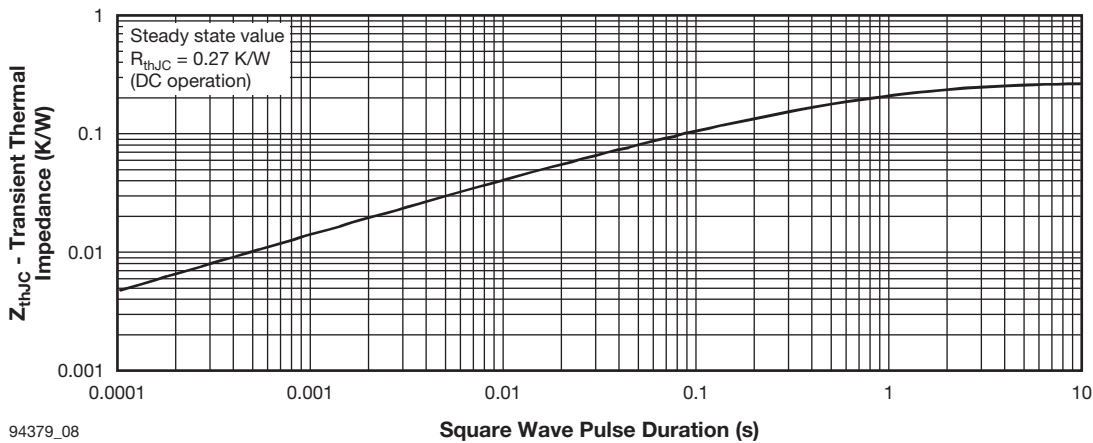


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristic

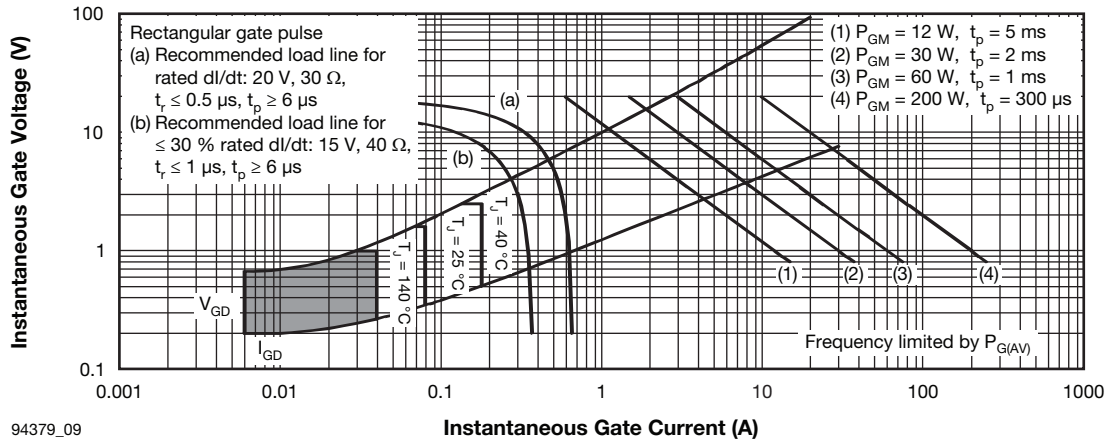


Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

|             |            |           |          |            |            |            |
|-------------|------------|-----------|----------|------------|------------|------------|
| Device code | <b>VS-</b> | <b>11</b> | <b>0</b> | <b>RKI</b> | <b>120</b> | <b>PbF</b> |
|             | ①          | ②         | ③        | ④          | ⑤          | ⑥          |

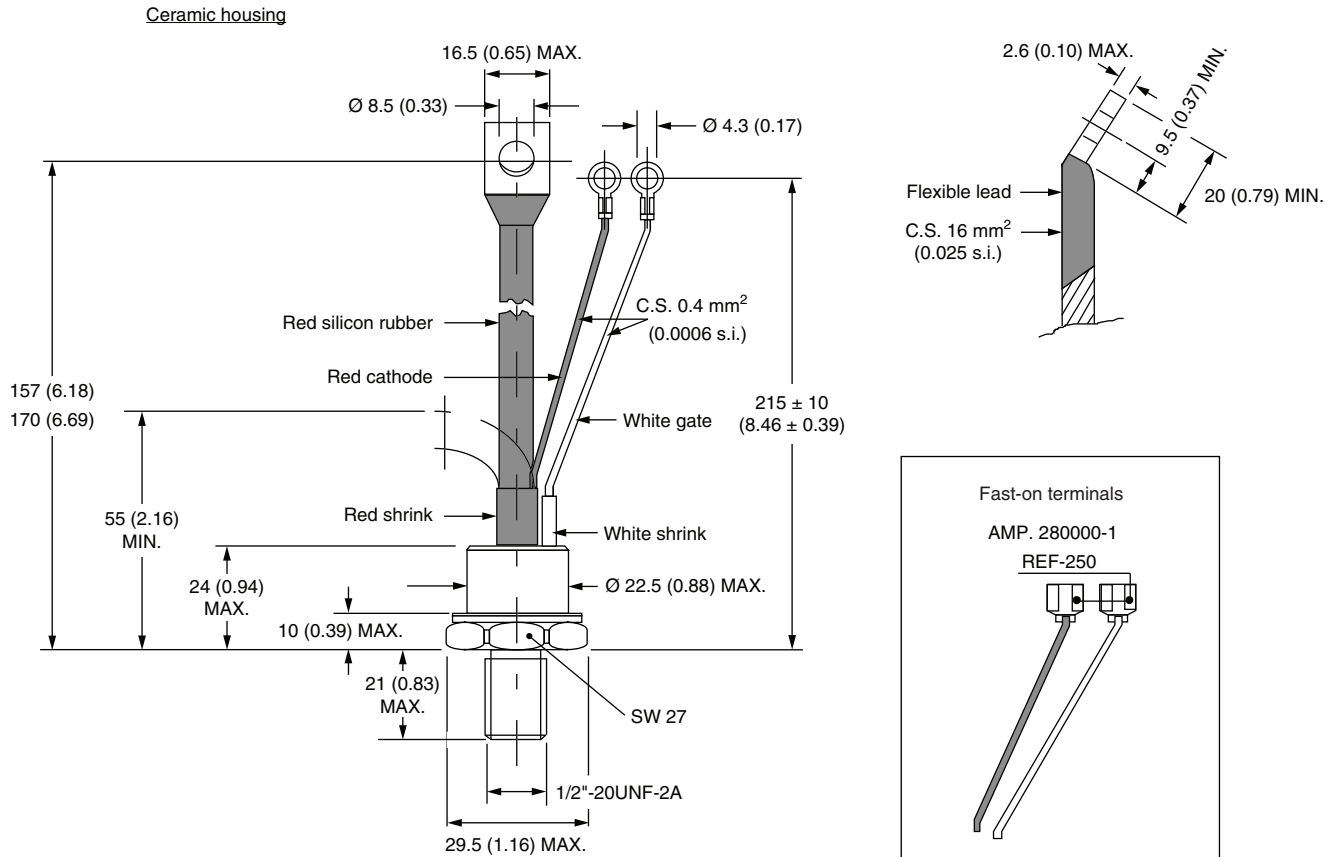
- 1** - Vishay Semiconductors product
- 2** -  $I_{T(AV)}$  rated average output current (rounded/10)
- 3** -
  - 0 = Eyelet terminals (gate and auxiliary cathode leads)
  - 1 = Fast-on terminals (gate and auxiliary cathode leads)
- 4** - Thyristor
- 5** - Voltage code x 10 =  $V_{RRM}$  (see Voltage Ratings table)
- 6** -
  - None = Standard production
  - PbF = Lead (Pb)-free

### LINKS TO RELATED DOCUMENTS

|            |  |
|------------|--|
| Dimensions | <a href="http://www.vishay.com/doc?95003">www.vishay.com/doc?95003</a> |
|------------|--|

## TO-209AC (TO-94) for 110RKI and 111RKI Series

**DIMENSIONS** in millimeters (inches)



**Note**

- For metric device: M12 x 1.75 contact factory



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